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VERIFICATION OF TRANSLATION

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declare that I am a professional translator well acquainted with both the German and English languages, and that the attached is an accurate translation, to the best of my knowledge and ability, of the accompanying German document.

Signature ____________________ Date 12/19/05

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Eccentric Transmission With an Imbalance Compensation Element

Prior Art

The present invention is based on an eccentric transmission with an imbalance compensation element according to the preamble to claim 1.

The prior art already includes proposals to equip a hand-held power tool with an eccentric transmission that is provided to convert a revolving rotary motion of an armature shaft into an oscillating rotary motion of a drive shaft in order to drive an insert tool of the hand-held power tool to oscillate. Known eccentric transmissions have disk-shaped imbalance compensation elements that are slid or press-fitted onto the drive shaft.

Advantages of the Invention

The present invention is based on an eccentric transmission with an imbalance compensation element and with an eccentric element for converting a revolving rotary motion of an armature shaft into an oscillating rotary motion of a drive shaft in order to drive an insert tool of a hand-held power tool to oscillate.

According to the invention, the imbalance compensation element is integral to an additional functional unit. This makes it possible to reduce the number of components and save on production costs and also permits the ruggedness of the eccentric transmission to be increased. This also has the capacity to advantageously eliminate error sources in an assembly process.

In the context of this application, the term “eccentric element” is understood to indicate a device with a drive element situated eccentric to a

rotation axis, in particular a drive pin, which, in a particularly advantageous embodiment, can have two offset axes parallel to each other. The imbalance compensation element generates a compensation imbalance that is situated opposite from and thus compensates for an imbalance generated by the eccentric element and by eccentrically rotating components connected to it.

In particular, an error in the relative orientation of the eccentric element and the imbalance compensation element can be avoided if the additional functional unit is the eccentric element.

An inexpensive manufacture of the imbalance element can be achieved if the imbalance compensation element includes a recess. In this connection, the imbalance compensation element can in particular be embodied in the form of a rotationally symmetrical component in which the recess is subsequently produced in order to generate an imbalance. If the eccentric element has a drive pin, the recess can be oriented in the same direction as the drive pin. A particularly precise dimensioning of the imbalance can be achieved if the imbalance compensation element contains a bore. As a result, it is also possible to achieve a quiet movement of the imbalance compensation element if it has a rotationally symmetrical outer casing that covers the – in particular axially oriented – bore.

Edges that could generate running noise can be avoided and a particularly compact design can be achieved if the imbalance compensation element is comprised of an outer casing of the eccentric element. This can be implemented in a particularly advantageous way by means of an axis of the outer casing that is offset in parallel fashion in relation to a rotation axis of the eccentric element or in relation to a driving element.

A tilting moment perpendicular to the rotation axis of the eccentric element and/or of the armature shaft can be advantageously compensated for if one axis

of the outer casing is tilted in relation to at least one axis of the eccentric element.

An inexpensive eccentric transmission with compensation of components of a turning moment and/or tilting moment oriented perpendicular to the rotation axis can be achieved if the imbalance compensation element has a cross section that changes in the axial direction. In this connection, a particularly precisely tuned imbalance compensation element can be achieved if the imbalance compensation element has at least two axially offset regions that have different imbalances.

There are also conceivable embodiments in which the additional functional unit integral to the imbalance compensation element is the armature shaft. This makes it possible to achieve an eccentric element that has a high degree of symmetry and is inexpensive to manufacture.

An effective imbalance compensation element can be achieved for a particularly low engineering cost if the imbalance compensation element includes a lateral flattened region on the armature shaft.

There are also conceivable embodiments in which several separate imbalance compensation elements are provided, which are integrated into different functional units. Then, a relative orientation of the imbalance compensation elements can be advantageously selected so as to compensate for a tilting moment.

Drawings

Other advantages ensue from the following description of the drawings. The drawings depict exemplary embodiments of the invention. The drawings, description, and claims contain numerous defining characteristics in combination.

Those skilled in the art will also suitably consider the defining characteristics individually and unite them into other meaningful combinations.

Fig. 1 shows a hand-held power tool with a drive shaft that can be driven to oscillate,

Fig. 2 shows an eccentric transmission of the hand-held power tool from Fig. 1,

Figs. 3a – 3c show a front view, a sectional view, and a rear view of an eccentric element of the eccentric transmission from Fig. 2,

Figs. 4a – 4c show a front view, a sectional view, and a rear view of an alternative eccentric element of an eccentric transmission,

Figs. 5a – 5c show a front view, a sectional view, and a rear view of another alternative eccentric element of an eccentric transmission,

Figs. 6a – 6c show a front view, a sectional view, and a rear view of another alternative eccentric element of an eccentric transmission, and

Fig. 7 shows another alternative eccentric element and an armature shaft with an integrated imbalance compensation element.

Description of the Exemplary Embodiments

Fig. 1 shows a hand-held power tool 18a with an electric motor 36a contained in a housing (Fig. 2). By means of an eccentric transmission, the electric motor 36a sets a drive shaft 16a protruding from the housing into oscillation. During operation, the drive shaft 16a pivots back and forth by several

degrees in an oscillating fashion. At its end protruding from the housing, the drive shaft 16a has a fastening device 42a to which an insert tool 40a can be attached in a nonrotating fashion. The fastening device 42a acts as a clamping connection in the axial direction. The oscillating motion of the drive shaft 16a is converted into an oscillating pivoting motion 44 of the insert tool 40a.

Fig. 2 shows the eccentric transmission of the hand-held power tool 18a. In order to convert the revolving rotary motion of an armature shaft 14a, which the electric motor 36a generates, into the oscillating rotary motion of the drive shaft 16a, an eccentric element 12a is press-fitted onto the armature shaft 14a of the electric motor 36a.

The eccentric element 12a has a rear region containing a bore, which is provided to receive one end of the armature shaft 14a. In the front region, the eccentric element 12a has a cylindrical drive pin 38a. An axis 26a of the drive pin 38a is offset eccentrically and/or in parallel fashion to an axis 24a of the bore so that a rotary motion of the armature shaft 14a generates an eccentric rotary motion of the drive pin 38a.

A ball bearing 34a is slid onto the drive pin 38a. An oscillating link 32a of the eccentric transmission is fork-shaped, rests against both sides of an outer circumference of the ball bearing 34a, and is nonrotatably connected to the drive shaft 16a. An orbital motion of the ball bearing 34a generates to oscillating pivoting motion of the oscillating link 32a. The pivoting motion of the oscillating link 32a is transmitted to the drive shaft 16a, which is supported in the housing of the hand-held power tool 18a by means of a ball bearing 46a, and converts this motion into the pivoting motion 44a of the insert tool 40a.

The eccentric element 12a has a recess embodied in the form of a flattened area, which constitutes an imbalance compensation element 10a and is integral to the eccentric element 12a (Figs. 3a – 3c). The imbalance

compensation element 10a is aligned in the direction in which the drive pin 38a is offset from the axis 24a. The imbalance compensation element 10a is dimensioned so that a center of mass of a total system comprised of the eccentric element 12a and the ball bearing 34a lies on the axis 24a of the armature shaft 14a.

In the region of an end face of the bore in the rear region of the eccentric element 12a, the eccentric element 12a has an air compensation opening 48a through which air can escape from the bore when the eccentric element 12a is being press-fitted onto the armature shaft 14a.

Figs. 4 – 6 show alternative embodiments of an eccentric element 12a – 12e, each with an integrated imbalance compensation element 10a – 10e. The description below will primarily concentrate on the differences in relation to the exemplary embodiment shown in Figs. 1 – 3, whereas for those defining characteristics that remain the same, reference is hereby made to the description relating to Figs. 1 – 3. Analogous defining characteristics have been provided with the same reference numerals, but with the letters a – e added to them in order to differentiate among the exemplary embodiments.

Figs. 4a – 4c each show an eccentric element 12b with an imbalance compensation element 10b that is integral to the eccentric element 12b. The imbalance compensation element 10b is comprised of a cylindrical outer casing 22b of the eccentric element 12b, the axis 20b of which outer casing is offset from the axis 24b in parallel fashion, specifically in a direction opposite from the direction of an axis 26b of a drive pin 38b. The offsetting of the axis 20b shifts a center of mass to the axis 24b.

Figs. 5a – 5c each show an eccentric element 12c with an imbalance compensation element 10c integral to the eccentric element 12c. The imbalance compensation element 10c is comprised of a cylindrical outer casing 22c of the

eccentric element 12c, the axis 20c of which outer casing is tilted in relation to the axis 24c of an armature shaft 14c and to an axis 26c of a drive pin 38c of the eccentric element 12c. The tilting shifts a center of mass to the axis 24c and compensates for a tilting moment generated by the drive pin 38c and oriented perpendicular to the axis 24c.

Figs. 6a – 6c show another alternative eccentric element 12d with an imbalance compensation element 10d integral to the eccentric element 12d. The imbalance compensation element 10d has a cross section that changes in the axial direction (Fig. 6b). The imbalance compensation element 10d has two axially offset regions 28d, 30d, each of which constitutes a flattened region of an otherwise circular cross section of the eccentric element 12d. The flattened regions 28d, 30d are situated opposite from each other and generate a tilting moment, which in turn generates a tilting moment that is oriented perpendicular to an axis 24d of a bore provided to receive an armature shaft 14d and compensates in several planes for a tilting moment generated by a drive pin 38d of the eccentric element 12d. The regions 28d, 30d have different respective imbalances, each oriented opposite the other and of a different magnitude.

Fig. 7 shows another embodiment of the invention that has an imbalance compensation element 10e integral to an armature shaft 14e. The imbalance compensation element 10e is embodied in the form of a lateral flattened region of the armature shaft 14e.